ERDC/CERL SR-12-6

US Army Corps of Engineers®
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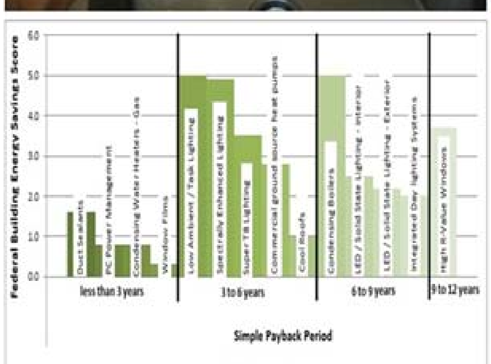
Energy Savings and Sustainability Opportunities at US Army Corps of Engineers Facilities

A Guide To Identify, Prioritize, and Estimate Projects at Complexes That Have Not Conducted a Facility-Level Energy and Water Evaluation

David M. Underwood and Laura Curvey

June 2012



Construction Engineering Research Laboratory

Center for the Advancement of
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Construction Engineering Research Laboratory (CERL)
U.S. Army Engineer Research and Development Center
2902 Newmark Dr.
Champaign, IL 61822-1076

Center for the Advancement of Sustainability Innovation (CASI)

Final Report

Prepared for Headquarters, U.S. Army Corps of Engineers
Washington, DC 20314-1000

Abstract

Executive Order (EO) 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, expanded on the energy reduction and environmental performance requirements of Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, by adding sustainability requirements and performance planning, and also by establishing goals for water efficiency improvement. EO 13514 requires agencies to reduce their energy intensity 3% per year through fiscal year 2020 (FY20) based on an FY03 baseline (for a total of 30%) and to reduce their water intensity 2% per year through FY20 based on an FY07 baseline (for a total of 26%). This document provides basic tools, methods, assistance, and information sources to non-energy facility managers in the US Corps of Engineers to help identify and develop energy and water conservation projects in the facilities for which they are responsible.

Executive Summary

This guide was developed to help US Army Corps of Engineers (USACE) facilities (such as Civil Works Operations projects) and Corps-owned District Headquarters complexes *that have not conducted* a facility-level energy and water evaluation to identify, prioritize, and perform cost/benefit estimation for energy and water efficiency improvements.

To begin planning efficiency improvements, facility managers must first be familiar with the supply and demand of energy and water throughout their facility. To identify energy and water conservation measures (ECMs), an energy manager would generally start by performing an Energy and Water Conservation Assessment, essentially a facility-level evaluation of the energy and water consuming equipment and systems that focuses on assessing levels of energy and water efficiency and identifying ECMs to improve efficiency. Note that sites having less than $35,000 per year utility cost and/or an aggregate building square footage of less than 30,000 sq ft may not present conservation opportunities that justify the cost of an energy assessment.

In situations where time restrictions or funding limitations require the identification of ECMs without conducting a facility-level energy and water evaluation, energy and water conservation measures may be identified by comparing your facilities with other similar facilities that have undergone evaluations.

In addition to this field guide, you can access the reports of all USACE facility-level energy and water evaluations on the Environmental Community of Practice's Engineering Knowledge Online Sustainability Page through URL:

https://eko.usace.army.mil/usacecop/environmental/sustainability/msc/

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Preface

This study was funded by and conducted for Headquarters, US Army Corps of Engineers (HQUSACE) by the Center for the Advancement of Sustainability Innovations (CASI) under the Sustainability Planning project. The technical monitor(s) were Antonia Giardina, USACE Sustainability Program Manager, and John Coho, Senior Advisor for Environmental Compliance.

The work was performed by the Energy Branch (CF-E) of the Facilities Division (CF), Construction Engineering Research Laboratory (CERL). Mr. Franklin Holcomb is Chief, CF-E, and Mr. Michael Golish is Chief, CF. The Director of CASI is Mr William D. Goran and Michelle Hanson is the Associate Director. The Director of ERDC-CERL is Dr. Ilker R. Adiguzel.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Commander and Executive Director of ERDC is COL Kevin J. Wilson, and the Director of ERDC is Dr. Jeffery P. Holland.

1 Introduction

1.1 Background

Executive Order (EO) 13514, *Federal Leadership in Environmental, Energy, and Economic Performance* (White House 2009), expanded on the energy reduction and environmental performance requirements of Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management* (White House 2007) by adding sustainability requirements and performance planning, and also by establishing goals for water efficiency improvement. EO 13514 requires agencies to reduce their energy intensity 3% per year through fiscal year 2020 (FY20) based on an FY03 baseline (for a total of 30%) and to reduce their water intensity 2% per year through FY20 based on an FY07 baseline (for a total of 26%). This document provides US Army Corps of Engineers (USACE) non-energy facility managers with basic tools, methods, assistance, and information sources to identify and develop energy and water conservation projects in the facilities for which they are responsible. This guidance may be applied differently at each site because Corps of Engineers Civil Works Project Offices and District Offices vary by type, function, age, design, and construction.

1.2 Objectives

The objective of this work was to provide Corps of Engineers non-energy facility managers with basic tools, methods, assistance, and information sources to identify and develop energy and water conservation projects in the facilities for which they are responsible.

1.3 Approach

This field guide was the result of the synthesis of the results of a broad literature review of USACE facility-level energy and water evaluations conducted at USACE facilities. Chapter 2 provides general guidance on how facility managers should approach the assessment of their facility's energy and water demands to find opportunities to reduce those demands, and thereby meet the energy requirements of EO 13514. Chapter 3 describes typical projects that have generally good Return on Investment (ROI) paybacks. Chapter 4 describes basic methods for estimating costs and savings.

1.4 Scope

While the findings and recommendations in this document apply broadly to all Corps of Engineers' facilities, they may be applied differently at each site because Corps of Engineers Civil Works Project Offices and District Offices are varied in type, function, age, design, and construction.

1.5 Mode of technology transfer

This report will be made accessible through the World Wide Web (WWW) at URLs:

http://www.cecer.army.mil

http://libweb.erdc.usace.army.mil

https://eko.usace.army.mil/usacecop/environmental/sustainability/goals/

2 Identifying Conservation Opportunities

This chapter provides a general guide on how facility managers should approach the assessment of their facility's energy and water demands to find opportunities to reduce those demands, and thereby meet the energy requirements of EO 13514.

2.1 Where to look for the most cost-effective energy and water conservation opportunities at your facilities

The most cost-effective energy and water conservation opportunities in Corps of Engineers' facilities can be found in buildings that are heated and/or cooled and lighted, AND that:

- have long operating hours, and/or have high use/occupancy by USACE personnel and visitors
- have intermittent occupancy
- are in extreme climates
- have not been renovated recently
- have extensive irrigation for landscaping.

2.2 Typical cost-effective ECMs

Some typical cost-effective ECMs include:

- In general turn things off when they are not needed, for example:
  - lighting
  - heating, ventilating, and air-conditioning (HVAC, e.g., boilers, chillers, air handling units, pumps, unit heaters, fan coil units, etc.).
- Seal buildings for air-tightness and install cool roofs (often low-cost, high payback ECMs). Note that many other building envelope ECMs (e.g., increased insulation in walls and roofs, window replacement for example) tend to have long payback periods. It may be best to undertake these measures during normal/routine planned renovation.
- Improve efficiency of HVAC equipment/systems (equipment scheduling, oil-less compressors, ground-source heat pumps, direct digital control [DDC], etc.) including commissioning. More detailed information is available through URL: http://www.peci.org/sites/default/files/annex_report.pdf
- Replace old, inefficient lighting (redesign space lighting).

- Install up-to-date control systems to regulate HVAC temperature and operation hours.
- Install controls to regulate lighting.
- Install more efficient domestic water heating equipment.
- Install natural lighting (daylighting).
- Install solar hot water heating, especially for pools, barracks, and gyms.
- Replace standard restroom fixtures with low-flow fixtures.
- Replace inefficient commercial hot water appliances with efficient ones.
- Finding and repair leaks in water systems.
- Retro-commission buildings (i.e., perform a “building tune-up”).

3 Typical Projects with Good Payback

3.1 Typical savings

This chapter describes some typical, straight-to-the-point projects that generally have good ROI paybacks. The Federal Energy Management Program (FEMP) has produced a simple graphic showing the FEMP energy savings score (in which a higher score is better) and simple payback period for a variety of these projects (Figure 1). Facilities typically employ a range of projects with varying costs, paybacks, and energy savings returns.

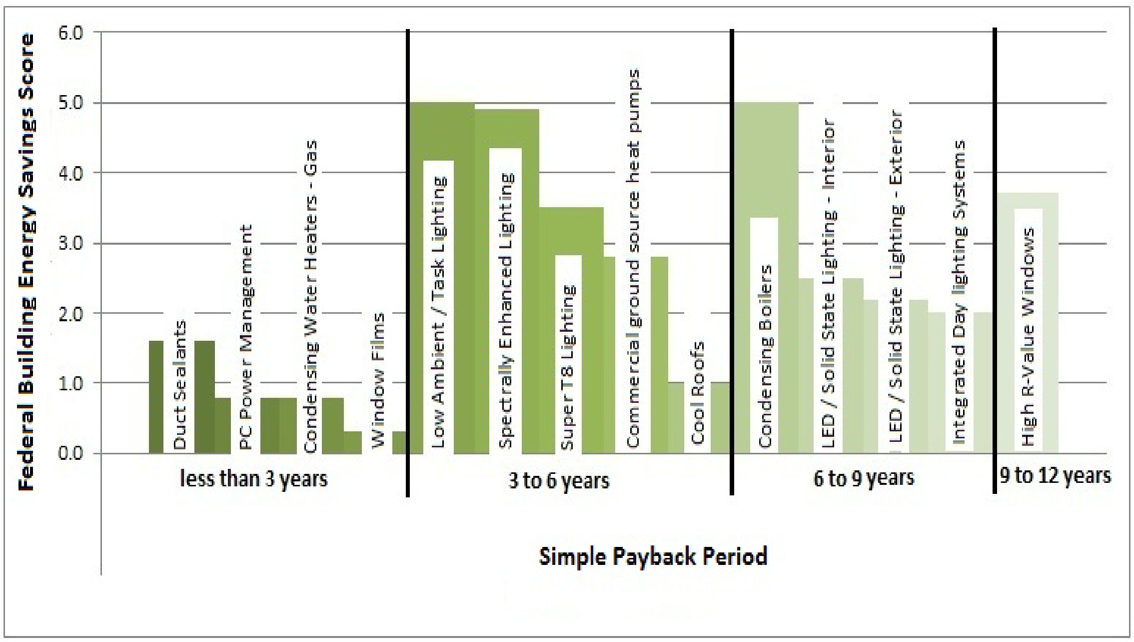

Figure 1. Energy savings project types and their payback period

3.2 Low-cost projects

3.2.1 Building envelope

Reduce infiltration by installing weatherstripping, fixing holes in walls, and sealing heating and cooling vents and conduits.

3.2.1.1 Weatherstripping

The simple installation of missing weatherstripping and door skirts on the doors at Humphreys Engineer Center, VA (HNC) significantly improved the building envelope (Figure 2).

Figure 2. Door with missing weather stripping in Kingman Building, Camp Humphreys, VA.

A study by the Energy Engineering Analysis Program (EEAP) for energy optimization estimated that an expenditure of $1400 to install skirts and strips throughout the building would result in approximate annual savings of $9095 for a simple payback (SP) of just under 2 months.

3.2.1.2 Simple payback formula

First-Cost ($) ÷ Annual Energy Cost Savings ($) = Years
Example: $150,000 ÷ $50,000 = 3.0 years until costs are recouped
(Efficiency Partnership 2012)

3.2.2 Appliance controls

3.2.2.1 Vend-misers

In most government facilities, vending machines run continuously, 24/7 (Figure 3). It is recommended that facilities that do not have overnight staff install "Vend Miser" type devices on each machine. A Vend Miser uses motion sensors to detect customers while regularly cycling the machines compressors to maintain desirable temperatures of the products contained inside. An initial investment of $330 for each machine typically yields average savings of $176/year/machine for an SP of 1 year, 10 months.

Figure 3. Typical vending machines at facilities.

Source: www.phillyfacility.com

Figure 4. Bollard lamps example.

3.2.3 Low-cost improvements to HVAC controls

A low-cost way to improve HVAC controls is by scheduling air handling unit (AHU) operation by:

- installing time clocks and/or
- adjusting existing DDC schedules.

3.2.4 Low-cost lighting energy conservation measures

Replace outdoor metal halide lamps with light emitting diode (LED) solar fixtures. LED lamps offer many advantages over metal halide lamps. They use ~75% less energy, maintain the same quality of light (and more consistent illumination), provide immediate full illumination when switched on, generate less heat, and last much longer. Metal halide lamps have a 15,000 to 20,000-hr lifespan; LEDs, which have typical life spans of ~100,000 hours, reduce maintenance costs.

For example, the Kerr Lake's comfort station, Tanner Center and Visitor Assistance Center all use 175 watt metal halide bollard lamps (Figure 4). Replacing these existing lamps with solar LED lamps would save ~$2100 per year in energy savings and maintenance costs.

Source: USEPA

Figure 5. Water efficient landscaping in Colorado

3.2.5 Water

3.2.5.1 Outdoor

Eliminate potable water irrigation sites and plants with high water demand by xeriscaping (i.e., landscaping in ways that reduce or eliminate the need for supplemental water from irrigation). Xeriscaping can conserve both energy and water, while giving a site a beautiful and unique appearance (Figure 5). By gradually replacing plants with high water demands, xeriscaping can provide a SP of less than 1 year.

3.2.5.2 Indoor

Replace faucet and dining facility water fixtures with high efficiency fixtures that are US Environmental Protection Agency (USEPA) WaterSense-approved. For example, shower heads should dispense no more than 2.5 gpm (gallons per minute). Several US Environmental Protection Agency (USEPA) WaterSense-approved shower head models (Figure 6) dispense from 1.0 to 1.75 gpm. Showerheads provide immediate payback in both water and hot water heating costs. Note that, if scaling from lime buildup is an issue, it is recommended not to install showerheads that dispense less than 1.5 gpm.

The standard bathroom sink faucet should dispense no more than 1.0 gpm. Some Watersense models are rated as low as 0.5 gpm.

Pre-rinse spray valves at dining facilities should dispense no more than 1.6 gpm. Some Watersense models are rated as low as 1.25 gpm.

Source: Niagara.

Figure 6. Model N2912CH Shower head has a flow rate of 1.25 at high pressure and 1.0 gpm at low pressure.

For example, many dining facilities use high flow pre-rinse spray valves (PRSVs) that normally have hot water flow rates of 5.0 gpm (Figure 7). Newer model low-flow pre-rinse valves have flow rates of less than 1.6 gpm, and some models are available with flow rates as low as 1.25 gpm. SP is almost immediate. Replacement cost is typically $65. If the PRSV is used 1 hour after each meal (3 hours a day), then switching from a 5.0 gpm to a 1.6 gpm PRSV will save ~224,000 gal of water a year. Calculations on the water and energy savings calculator from the Food Service Technology Center (Fisher-Nickel, Inc. 2012a) indicate that the use of low-flow pre-rinse valves could save around $6700 annually in combined annual water, heat energy, and sewer costs.

3.2.5.3 Domestic water heating

Reduce the costs of domestic water heating by:

- Insulating hot water heater, tank, and piping, which can have an SP of 4 months
- Installing solar hot water heating
- Replacing inefficient hot water heater with high efficiency one.

Source: Underwood (2011)

Figure 7. High flow pre-rinse spray valves.

Figure 8. Existing electric water heater at Raystown Lake.

For example, the domestic hot water (DHW) needs of Raystown Lake facility are currently being provided by electric hot water heater storage tanks (Figure 8), which constantly maintain the temperature of a fairly large body of standing water for only intermittent DHW needs.

Maintaining temperature in a standing tank wastes energy; heat escapes from the tank and from poorly insulated pipes that carry the hot water from the tank to the point of use. Raystown Lake plans to replace the electric hot water heater tanks with heat pumps to serve their DHW needs. Since these heat pumps consume approximately one-half the energy of standard electric hot water tank heaters, this heat pump installation will reduce electrical consumption while meeting the DHW needs of the facilities. The upgrade installation will cost ~$30,000 and will yield an annual savings of $4500 for an SP of 6.5 years.

3.3 Moderate cost projects

3.3.1 Upgrade HVAC controls

The installation of DDC controls programmed with energy conservation algorithms can improve the energy of an HVAC system (Figure 9). The Kingman and Cude buildings at the HNC, for example, currently have old, inefficient pneumatic HVAC control systems interfaced with a modern DDC head end. Although the DDC control facilitates the interface with the Building Management System (BMS) computer, the pneumatic control of the terminal units results in substantial energy losses due both to the energy use by the air compressor and inaccuracy in the control of the system.

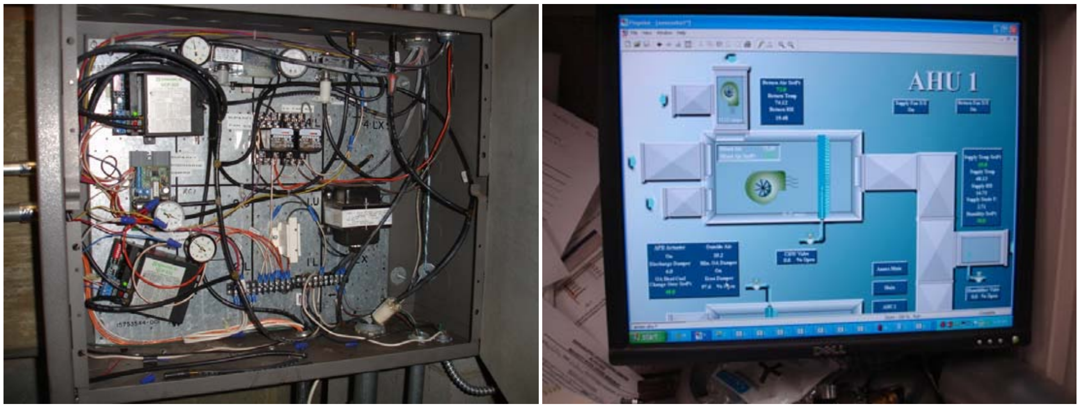

Figure 9. Old (left) and new (right) DDC control system at the HNC.

By upgrading all buildings to existing Andover controls system, the Kingman and Cude buildings would share in the automation capabilities of the Andover software. Typically, most standard energy management control systems (EMCSs) support the following programmable control sequences:

- scheduling (based on building occupancy periods)
- chilled and hot water reset (based on outside air temperature)
- supply air temperature reset (constant volume systems)
- thermostat controls
- start/stop optimization
- economizer controls
- building lighting programmable controls
- alarming.

When a new EMCS installation is being considered or a replacement of an existing EMCS is being planned, a detailed plan is essential. The plan should address the following items:

- current installed EMCS (hardware, operator interfaces, communication, existing base EMCS infrastructure and compatibility)
- future needs
- training needs
- commissioning needs.

3.3.2 Upgrade HVAC – other than controls

HVAC upgrades (other than controls) to consider are:

- Replace forced air heating with radiant heating.
- Implement demand control ventilation of outside air.
- Replace forced air heating with radiant heating.
- Add energy recovery with building exhaust air.

3.3.3 Projects for unheated water

Some projects to conserve (unheated) water (for which the payback schedule would depend on local water rates) are:

- Replace all 3.5 gpf toilets with 1.6 gpf toilets.
- Replace all 1.6 gpf urinals with 0.6 gpf urinals.
- Install drip irrigation and smart irrigation controls.
- Install composting toilets at remote locations.

3.4 High-cost projects

3.4.1 Energy projects

Some high-cost ECMs include:

- Replace once-through chillers with a closed loop system.
- Replace steam-based heating systems (central plants, distribution lines, and building components) with hot water systems.
- Replace boilers or chillers with high efficiency models.

In many cases, existing cooling technologies are not as efficient as they could be. It is not uncommon for chiller coefficients of performance (COPs) to be as low as 3.5. The solution is to replace them with water-cooled centrifugal chillers having COPs of 5.3 or higher. Savings can be estimated using the Facility Energy Decision System (FEDS) tool developed by Pacific Northwest National Laboratory (PNNL). RSMeans cost estimating can provide costs depending on size. (See Chapter 4 for details.)

In the long, electric boilers waste energy and are typically less cost effective run than gas boilers. The cost to replace the electric boilers at the Cude annex at Camp Humphreys (Figure 10) would be ~$79,000. Annually expected savings with higher efficiency gas boilers is $23,000 for an SP of just over 3 years.

3.4.2 Water projects

Water is typically much cheaper than energy so that higher cost water conservation projects typically do not have immediate payback if water rates are low. However, when alternative water supplies become essential and water availability is limited, some reasonable options might include:

- using a rainwater catchment system for irrigation or dust control
- installing a graywater treatment system to recycle and reuse water for non-potable uses.

Figure 10. Electric boilers at Cude Annex in Camp Humphreys, VA.

3.5 Prioritizing ECM implementation

To prioritize ECM implementation, one must estimate costs and savings of potential projects. Savings for these phases of ECM implementation (0 and I) are usually estimated using simple calculations. For example, ECMs may be prioritized by comparing Savings to Investment Ratios (SIRs), where the ECMs with higher SIRs would receive higher priority. For larger projects, Energy Savings Performance Contracts (ESPCs) are an option where cost estimates and project prioritization are done by a private party. Costs may also be estimated by using actual expenditures from past projects, or by using cost estimating tools such as RSMeans. Another possibility is to request cost estimates from equipment vendors.

Energy and water evaluations can be of varying detail, but are necessary to help understand the biggest factors for demand and determine the areas where savings opportunities lay. If facility managers plan to do a complete evaluation, they can assume some basic costs associated with a level of effort required. Costs of a Level I evaluation range between $0.04 to $0.15 per square foot (including Level 0 work) depending on the size, mission, and complexity of the facilities to be evaluated. There is, of course a minimum cost associated with an evaluation. Civil Works (CW) sites should plan on a minimum budget of $30k –40k (including onsite personnel support). Level II and Level III evaluations are more detailed and will require more level of effort. (See Underwood and Allen [2011] for more detail.)

4 Estimating Costs and Savings

This chapter describes basic methods for estimating costs and savings. More detailed information on what to look for within facilities, how to perform calculations, and how to organize and perform energy and water evaluations and is given in the *Corps of Engineers Field Guidance Package for Assessment of Energy and Water Conservation Opportunities at USACE Facilities* (Underwood and Allen 2011), which may be accessed via:

https://eko.usace.army.mil/virtualteams/hnc_energy/?syspage=Documents&id=244432

4.1 Estimating costs

Facility managers can easily obtain projects quotes from vendors. However, to ensure that the vendors are providing valid and cost-effective numbers, facility managers should refer to RSMeans annual publications such as *Repair and Remodeling Cost Data* and *Facilities Maintenance and Repair Cost* (RSMeans 2011). These annual publications provide good current information to help verify and cross check vendor quotes, and to provide accurate costs to perform life-cycle cost analyses and to create payback schedules for use in preparing proposals or work orders.

Each annual publication contains directions for its use. Each RSMeans catalog is categorized by type of material, unit price, and related cost for installation. RSMeans requires you to know the number of units that will be installed, fixed, or replaced, and the approximate overhead percentage that the contractor or your agency requires (Table 1). The prices in RSMeans are based on the average costs of 30 cities throughout the United States so depending on your location throughout the states, the labor and unit cost may need to be adjusted. Each book contains a table that provides a multiplication factor that must applied as it pertains to the project location. RSMeans catalogs are available in both book and online subscription formats (www.meanscostworks.com).

Table 1. Example estimating equipment costs for air handler unit control.

Controller	1 ea	@ $750	$750
CO_2 sensor	1 ea	@ $350	$350
Damper Actuator	2 ea	@ $125	$250
Installation	LS		$250
Calibration/balancing	LS		$350
Total			**$1950**

4.2 Estimating savings

The *Corps of Engineers Field Guidance Package* (Underwood and Allen 2011) provides several examples and formulas of how to calculate savings for both energy and water projects at:

https://eko.usace.army.mil/virtualteams/hnc_energy/?syspage=Documents&id=244432

Several tools are available in Excel® spreadsheet form, as online web-based tools, and as printed documents. It is not uncommon to leverage water savings for energy projects and vice versa. Energy and Water savings can be measured in MMBtu, kWh, Kgal savings per year, Green House Gas reductions, reduced maintenance costs, along with avoided capital improvement costs. (For example, if a growing facility improves efficiency, thereby reducing demands on its infrastructure capacity, then capital improvement projects such as expanding a waste water treatment plant to match projected growth can be avoided by the increased efficiency measures or reduced overall consumption.) HVAC improvements should consider savings for both heating and cooling throughout the year.

A few of the many online tools available to operators to calculate savings for both energy and water throughout their facility (see the pre-rinse spray valve example, p 9) include:

Federal Energy Management Program (FEMP). 2011a. Energy and cost savings calculators for energy-efficient products. Web site. Washington, DC: US Department of Energy (DOE), http://www1.eere.energy.gov/femp/technologies/eep_eccalculators.html

US Small Business Administration (SBA). 2012. Energy saving calculators from ENERGY STAR. Web page, http://www.sba.gov/content/energy-saving-calculators-energy-star

Fisher-Nickel, Inc. 2012a. Life cycle and energy cost calculators. Web page. San Ramon, CA: Fisher-Nickel, Inc, http://www.fishnick.com/saveenergy/tools/calculators/

Fisher-Nickel, Inc. 2012b. Pre-rinse spray valve/water cost calculator. Web page. San Ramon, CA: Fisher-Nickel, Inc, http://www.fishnick.com/savewater/tools/watercalculator/

River Network. 2012. Water-energy toolkit: Understanding the carbon footprint of your water use. Web page, http://www.rivernetwork.org/water-energy-calculators

4.3 Funding

Sources of funding vary by many factors. Smaller low-cost projects may be funded from operation and maintenance (O&M) budgets. When appropriated funds are not available, ESPC or Utility Energy Service Contracts (UESC) should be considered. ESPCs can generally be used to implement

ECMs at one or more project sites, subject to a determination of economic viability that must be made by the contractor. The HNC is an internal USACE resource for addition information, technical support, and contracting for ESPCs and UESCs.

In general, an ESPC involves a contractor investing 3rd party funds to implement ECMs at a government facility. The contractor is then paid back, on a schedule established in the contract, from the savings that accrue to the facility (or facilities) as a result of energy savings. In a UESC, a utility company arranges funding to cover the capital costs of the project, which are repaid over the contract term from cost savings generated by the energy efficiency measures. Using ESPCs and UESCs, agencies can implement ECMs with little or no up-front capital investment. The net cost to the Federal agency is minimal, and the agency saves time and resources by using the "one-stop shopping" provided by the utility.

4.4 Tool to justify funding

The FEMP (2011b) website on the building life-cycle cost program provides tools for doing economic analyses on alternative buildings and building-related systems such as Leadership in Energy and Environmental Design (LEED) designed buildings, energy, and water conservation projects:

http://www1.eere.energy.gov/femp/information/download_blcc.html

The References section to this report (p 18) cites further sources that provide more detailed methods to calculate energy and water savings at your facility.

5 Conclusion

This work has provided basic tools, guidance, assistance, and sources to Corps of Engineers non-energy facility managers to identify and develop energy and water conservation projects in facilities for which they are responsible.

References

EEAP and Annex 46 Studies, https://eko.usace.army.mil/virtualteams/hnc_energy/teams/eeap/

Efficiency Partnership. 2012. Appendix 1: Financial definitions and online resources. Flex Your Power website). Accessed 19 March 2012. San Francisco, CA: Efficiency Partnership, http://www.fypower.org/pdf/fincalculators.pdf

Effinger, Joan, Hannah Friedman, Christopher Morales, Emilia Sibley, and Sarah Tingey. 15 December 2009. A study on energy savings and measure cost effectiveness of existing building commissioning. Berkeley, CA: Lawrence Berkeley National Laboratory (LBNL), http://www.peci.org/sites/default/files/annex_report.pdf

Energy and Water Conservation Design Guide (for Sustainment, Restoration and Modernization (SRM) Projects and MILCON Construction), ERDC-CERL

Energy Conservation Cost and Savings Spreadsheet, ERDC-CERL (draft expected to be available April 2012)

Federal Energy Management Program (FEMP). 2011a. Energy and cost savings calculators for energy-efficient products. Web site. Washington, DC: US Department of Energy (DOE), http://www1.eere.energy.gov/femp/technologies/eep_eccalculators.html

———. 2011b. Building Life-Cycle Cost (BLCC) programs. Web site. Washington, DC: US Department of Energy (DOE), http://www1.eere.energy.gov/femp/information/download_blcc.html

Fisher-Nickel, Inc. 2012a. Pre-rinse spray valve/water cost calculator. Web page. San Ramon, CA: Fisher-Nickel, Inc, http://www.fishnick.com/savewater/tools/watercalculator/

———. 2012b. Life cycle and energy cost calculators. Web page. San Ramon, CA: Fisher-Nickel, Inc, http://www.fishnick.com/saveenergy/tools/calculators/

Honeywell Corp. 1979. Energy conservation with comfort: The Honeywell energy conserver's manual and workbook. Morristown, NJ: Honeywell Corp.

Level I Energy Optimization Assessment, Buffalo District HQ Complex

Level I Energy Optimization Assessment, Humphreys Engineer Center Support Activity

Level I Energy Optimization Assessment, Kerr Lake. Learned, Tammie Huntsville Center et al.

Level I Energy Optimization Assessment, Raystown Lake, Learned, Tammie Huntsville Center et al.

Level I Energy Optimization Assessment, St. Louis District Service Base. Learned, Tammie Huntsville Center et al.

Loechl, Paul. 2004. Conserve water by xeriscaping residential lawns. White paper, http://www.cecer.army.mil/TD/TIPS/docs/xeriscaping.pdf

River Network. 2012c. Water-energy toolkit: Understanding the carbon footprint of your water use. Web page, http://www.rivernetwork.org/water-energy-calculators

RSMeans. 2011. RSMeans Facilities Maintenance & Repair Cost Data. Norwell MA: RSMeans, http://www1.eere.energy.gov/calculators/

Underwood, David M. and Amy Allen. 2011. Corps of Engineers field guidance package for assessment of energy and water conservation opportunities at USACE facilities. Champaign, IL: Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL), https://eko.usace.army.mil/virtualteams/hnc_energy/?syspage=Documents&id=244432

Underwood, David M., and Michael Kemme. 2012. Energy and greenhouse gas emission reduction opportunities for USACE unique CW projects. Draft ERDC/CERL Technical Report. Champaign, IL: Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL).

US Small Business Administration (SBA). 2012. Energy saving calculators from ENERGY STAR. Web page, http://www.sba.gov/content/energy-saving-calculators-energy-star

White House, The. EO 13514. 5 October 2009. Federal Leadership in Environmental, Energy, and Economic Performance. Federal Register 74(194):52117 52127.

White House, The. Executive Order (EO) 13423. 24 January 2007. Strengthening Federal Environmental, Energy, and Transportation Management. Federal Register 72(17):3919-3923.

Acronyms and Abbreviations

Term	Definition
AHU	Air Handling Unit
ANSI	American National Standards Institute
BMS	Building Management System
CASI	Center for the Advancement of Sustainability Innovations
CERL	Construction Engineering Research Laboratory
CMU	Concrete Masonry Unit
COP	Coefficient of Performance
CW	Civil Works
DC	District of Columbia
DDC	Direct Digital Control
DHW	Domestic Hot Water
ECM	Energy Conservation Measure
EEAP	Engineering Energy Analysis Program
EKO	Engineering Knowledge Online™
EMCS	Energy Management Control System
EO	Executive Order
ERDC	Engineer Research and Development Center
ESPC	Energy Savings Performance Contract
FEDS	Facility Energy Decision System
FEMP	Federal Energy Management Program
FY	Fiscal Year
HNC	Huntsville Center, Alabama
HQ	Headquarters
HVAC	Heating, Ventilating, and Air-Conditioning
LED	Light Emitting Diode
LEED	Leadership in Energy and Environmental Design
MILCON	Military Construction
NSN	National Supply Number
OMB	Office of Management and Budget
PNNL	Pacific Northwest National Laboratory
PRSV	Pre-Rinse Spray Valve
ROI	Return on Investment
SAR	Same As Report
SIR	Savings to Investment Ratio
SF	Standard Form
SME	Subject Matter Expert
SP	Simple Payback
SR	Special Report

Term	Definition
SRM	Sustainment, Restoration, and Modernization
UESC	Utility Energy Service Contract
UMCS	Utility Monitoring and Control System
URL	Universal Resource Locator
USACE	US Army Corps of Engineers
USEPA	US Environmental Protection Agency
WWW	World Wide Web

Appendix A: Energy Evaluation Considerations

How to start – Gather site data/define the scope of the evaluation

If you are planning to conduct and energy/water evaluation at your facility, first consider two overarching questions:

1. **How much energy and water is consumed, how, and where?**

   The first step is to examine the site as a whole to get a picture of energy and water used. Looking at the site as a whole indicates whether or not an energy evaluation is needed and, if so, what the focus of an audit should be. (Typically, sites having less than $35,000 per year utility cost and an aggregate building square footage of less than 30,000 sq ft may not present conservation opportunities that justify the cost of an energy assessment.)

   Reviewing past utility bills can provide monthly information about consumption and costs of electricity, natural gas, fuel oil, steam, liquid propane gas, and water on the site/compound. This information can be evaluated for consumption trends. (Three data years is recommended.) Typically, CW facilities are not individually metered, but are served under a master meter for each site (or group of buildings).

2. **What will you evaluate?**

   To help answer this question, assemble a building list that shows:
   - building function
   - conditioned (heated/cooled) area (square feet)
   - year constructed (age)
   - occupancy (number of employees and transient population)
   - hours of operation
   - energy sources used
   - types of water demand in building
   - irrigation system and schedule

  - o construction type (frame, concrete masonry unit [CMU], metal sandwich panel, etc.)
  - o historical buildings (buildings that cannot be substantially modified)
  - o buildings to be demolished (and when)
  - o building renovations (planned/ongoing and schedule)
  - o buildings in need of renovation in the near future.

Try to identify energy and water use in individual buildings so that the buildings that have the highest use intensities (most energy/water used per square foot of building space) can be targeted first. If building-specific metered data is not available, this can be done conceptually (without actually quantifying use) by looking at the energy and water consuming equipment in each building, its square footage, and hours of operation. From this information, you should be able to identify the largest energy/water consumers on site. In addition, building occupants or maintenance personnel can point to problems in the building that indicate energy use problems (space temperature issues, inadequate ventilation, drafts, leaking roofs, too little/too much light, mismatched lamps in lighting fixtures, etc.).

Also, try to identify energy/water consuming facilities or processes that are not directly controlled or changed by Corps personnel. Examples include electricity use at campgrounds, marinas, locks, dams, and industrial/floating plant service facilities. Then focus on conservation opportunities separately, concentrating on Corps-controlled facility uses versus all others.

Other useful information

If possible, it is always useful (and in the long run, saves time) to compile the following relevant information before the evaluation begins:

- real property data including site map (with building numbers)
- drawings of buildings to be evaluated, including floor plans, mechanical schedules, building envelope details (insulation type and thickness), etc.
- sub-metered energy and water use, preferably 2-3 years of data
- central heating and or cooling plant energy use
- reports from past evaluations
- the Installation Master Plan.

Further considerations

Finally, you may find it useful to prepare yourself for the evaluation by considering the following questions:

- Should the evaluation include use of one energy source instead of another (i.e., natural gas instead of electricity)?
- Should the evaluation consider saving energy or saving dollars?
- Are there central heating and or cooling plants and associated distribution?
- Is the climate primarily heating or cooling based or equally both?
- Is there a central monitoring and control system (typically called an EMCS or Utility Monitoring and Control System [UMCS])?
- Are there secure facilities that require advance notification for access?
- Should the evaluation include a wastewater treatment plant if located on site?
- Should the evaluation include stormwater management?

Once these questions have been answered, a picture of the critical items can be formulated and the evaluation may be focused appropriately. For instance:

- Is there a central heating plant and distribution system that is very inefficient and needs to be assessed?
- Buildings to be demolished in the near future are eliminated from the list.
- Very small buildings or buildings that have no heating, cooling, or lighting would also be eliminated.

The evaluation team needs to possess the necessary skills, knowledge, and experience necessary to assess the facilities and systems. If they do not, then others that do must be brought into the process, possibly by contracting subject matter experts (SMEs).

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From - To)
16-06-2012	Final	

4. TITLE AND SUBTITLE
Energy Savings and Sustainability Opportunities at US Army Corps of Engineers Facilities: A Guide To Identify, Prioritize, and Estimate Projects at Complexes That Have Not Conducted A Facility-Level Energy and Water Evaluation

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT

6. AUTHOR(S)
David M. Underwood and Laura Curvey

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Engineer Research and Development Center (ERDC)
Construction Engineering Research Laboratory (CERL)
PO Box 9005,
Champaign, IL 61826-9005

8. PERFORMING ORGANIZATION REPORT NUMBER
ERDC/CERL SR-12-6

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Headquarters, US Army Corps of Engineers (HQUSACE)
441 G St., NW
Washington, DC 20314-1000

10. SPONSOR/MONITOR'S ACRONYM(S)
CECW-CO-N

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
Executive Order (EO) 13514, Federal Leadership in Environmental, Energy, and Economic Performance, expanded on the energy reduction and environmental performance requirements of Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management, by adding sustainability requirements and performance planning, and also by establishing goals for water efficiency improvement. EO 13514 requires agencies to reduce their energy intensity 3% per year through fiscal year 2020 (FY20) based on an FY03 baseline (for a total of 30%) and to reduce their water intensity 2% per year through FY20 based on an FY07 baseline (for a total of 26%). This document provides basic tools, methods, assistance, and information sources to non-energy facility managers in the US Corps of Engineers to help identify and develop energy and water conservation projects in the facilities for which they are responsible.

15. SUBJECT TERMS
energy savings, energy conservation, Center for the Advancement of Sustainability Innovations, CASI, sustainability, project estimation, energy efficient, US Army Corps of Engineers Facilities

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER (include area code)
Unclassified	Unclassified	Unclassified	SAR	36	